Task Title: Development of Nondestructive Inspection Methods for Repairs of Composite Aircraft Structures

Investigation Team: David K. Hsu (PI), Daniel J. Barnard, John J. Peters, Vinay Dayal, Iowa State University. Industrial partners will include Boeing, Northwest Airlines, American Airlines, AANC, CACRC, and British RAF

Students: Brian Danowsky and Zachary Nielsen

Program initiation date: Awarded as IA047, September 18, 2001

Objective:

- To develop nondestructive inspection and evaluation methods that can provide quantitative information and images to aid the accept/reject decision making for repaired parts. Such techniques, with an ability to map out the morphology and mechanical condition of a repair, will provide the inspector with technical records of the repaired component while it remains in-service.

Research Activities:

- Survey existing repair methods and flaw types of concern. Acquire representative samples from industry partners for NDI development and destructive characterization
- Compare performance of CATT to mechanical impedance analysis and bond testing including use of AANC round-robin data/samples
- Develop protocol for use of CATT including correlation between images and repair morphology
- Transition results to industry partners including on-going evaluation with Iowa Army National Guard

Anticipated Results:

With increasing use of composites on control surfaces and primary load-bearing structure of the aircraft, quality assurance of repairs made on such components is essential to continued airworthiness. Field practice relies largely on hearing-based manual tap tests. Recent development of CATT (computer aided tap test) and availability of air coupled UT offers opportunities to understand the morphology and condition of a repair, to establish a correlation between imaged features and the actual internal state of the repair, leading to accept/reject criteria for repaired components that promote safe operation.

Accomplishments:

September 2001: Project initiated based on input from industry partners provided during the field tests of the computer aided tap tester (CATT). The CATT was commercialized in 2001 and will also be utilized as an assessment tool in this new project.

December 2001 and May 2002: Team meetings with NCAT composites team for coordination of project activities.

November 2001 ñ March 2002: Support of FAA and NTSB evaluation of the AA587 crash.

Publications and Presentations:

"NDE of Repairs on Aircraft Composite Structures," David K. Hsu, Daniel J. Barnard and John J. Peters, Proc. of SPIE, Vol. 4336, ***Nondestructive Evaluation of Materials and Composites V,*** edited by G. Y. Baaklini, E. S. Boltz, S. M. Shepard and P. J. Shull, 100-107, 2001.

"Development of Nondestructive Methods for Composite Repair Inspection", David K. Hsu, D. J. Barnard, J. J. Peters and V. Dayal, Review of Progress in Quantitative NDE, Bellingham, WA, July 14-19, 2002.

"Nondestructive inspection of composite and their repairs," D. K. Hsu, D. J. Barnard, J. J. Peters, V. Dayal and V. Kommareddy, 6th FAA/DoD/NASA Aging Aircraft Conference, San Francisco, CA, September, 2002

"Imaging Composite Honeycomb Structures using Computer Aided Tap Test and Air Coupled Ultrasound," ASNT Fall Conf. Nov. 4-8, 2002.

"Nondestructive Inspection of Repairs on Composite Aircraft Structures," David K. Hsu and Daniel J. Barnard, Review of Progress in Quantitative NDE, Brunswick, ME, July 29 - August 3, 2001.

"NDE of Composites: Quantitative evaluation of damage," David K. Hsu, FAA/NASA Workshop on Composites, Hampton, VA, June 2001.